

Electronics Research

1)What are some common types of sensors and actuator used in Robotics, and what do they measure? After researching, explain one situation in a robot where a sensor or actuator choice really matters.

Sensors are devices that permit a robot to gain information of its environment, while actuators permit it to act on that information. Common **sensors** include ultrasonic sensors (measure distance using sound waves), IR sensors (detect proximity or obstacles), temperature sensors (measure heat), encoders (measure rotation, speed, or position) and cameras (capture visual data). **Actuators** include DC motors (continuous rotation), servo motors (precise angular control), stepper motors (accurate step-by-step motion), pneumatic actuators (linear motion using air), and solenoids (on/off linear movement).

Situation where choice matters: In the IROC 25 Pict robotics club used lidar while other used other expensive sensors which had a positive impression solidifying upon their perfect final run.

2)What is a MOSFET, Research about MOSFETs from basic characteristics to applications. Explain one situation where a MOSFET is of utmost importance.

A MOSFET is a voltage-controlled semiconductor device used mainly for switching and amplification. It has three main terminals: Gate, Drain, and Source. When voltage is applied to the gate, it controls the current flow between drain and source. Its low gate current, high switching speed, high efficiency, and low heat loss compared to BJTs make it a better choice for it. Applications of MOSFET include motor drivers, voltage regulators and battery management systems.

Critical situation: In a robot motor driver, MOSFETs efficiently switch large currents required by motors without overheating, making them vital for reliable motor control.

3)Research about various microcontrollers and their uses, with a case study with special focus on ESP32.

Microcontrollers are very small computers used to control tasks in a Arduino and many other Electronic Components. Common microcontrollers include Arduino and ESP32 for IoT systems.

ESP32: The ESP32 is a capable microcontroller with built-in Wi-Fi and Bluetooth, dual-core processor and touch sensors. It is widely used in smart home devices, robotic controllers, and IoT-based robots. Its ability to handle networking and real-time motor/sensor control simultaneously makes it the best for robotic systems.

4)What is a Motor Driver, why is it required, why not just connect motors directly to the Microcontroller? Research about the most commonly used motor drivers commercially.

A motor driver is an electronic circuit that allows a microcontroller to control motors. Microcontrollers operate at low voltage and on the other hand motors require high current and voltage. Directly connection between a motor and a microcontroller would cause damage to it due to excess current and extra EMF. Motor drivers use **MOSFETs** to control motor direction, speed, and braking. Common commercial motor drivers include **L298N**, **L293D** for motors. These drivers protect the controller and enable precise motor control.

5)What is PWM, research about its significance with a case study

PWM is a technique used to modulate and vary the signal rather than the Binary (HIGH and LOW) Analog signals. PWM Toggles Analog signals so fast that it varies their duty cycle and hence their signal strength. It is heavily used to control motor speed, LED brightness, etc.

Case study: In a line-following robot, PWM is used to control the speed of DC motors. The robot can smoothly turn, accelerate/slow down without using inefficient methods, hence resulting in better control and efficient use of energy.

6)What are Power Distribution Boards (PDBs)? Research their role in robotic systems and explain why PDBs are used instead of directly supplying battery power to motor drivers and other subsystems.

Power Distribution Boards also known as PDBs are used to safely distribute power from a battery to various different parts in a robotic system, such as motor drivers, sensors, microcontrollers, etc. They include various electronic components such as voltage regulators, capacitors and protective measures.

Using a PDB instead of direct battery connections prevents voltage variance caused by motors, which can damage sensitive electronic components. PDBs help simplify wiring, improve reliability and ensure each part of the robot receives voltage, making them very important component in complex robots.